HUC 10280103 – Lower Grand
Water body IDs: 619 and 623
Pollutant(s): Pathogens as indicated by *Escherichia coli*

MISSOURI NATURAL RESOURCES

WATER PROTECTION PROGRAM

Total Maximum Daily Load
Implementation Strategies

for

Medicine Creek and Little Medicine Creek
Grundy, Mercer, Putnam, and Sullivan counties

Pollutants of concern: Pathogens

Completed: January 25, 2019

Prepared by: Watershed Protection Section

Summary of Water Bodies

Pollutant: Pathogens as indicated by *Escherichia coli (E. coli)*

Name: Medicine Creek
Location: Grundy, Sullivan, and Putnam counties

Name: Little Medicine Creek
Location: Grundy and Mercer counties


Location of watersheds in Missouri

8-digit Hydrologic Unit Code (HUC):[1]
10280103 – Lower Grand Subbasin

10-digit HUC Subwatersheds
1028010301 – Little Medicine Creek
1028010302 – Headwaters Medicine Creek

Water Body Identification Number (WBID) and Hydrologic Class:[2]
Medicine Creek: WBID 619 – Class P
Little Medicine Creek: WBID 623 – Class P

Designated Uses:[3]
Irrigation
Livestock and wildlife protection
Human health protection
Protection and propagation of fish, shellfish and wildlife – warm water habitat
Whole body contact recreation category B
Secondary contact recreation

Impaired Use:
Whole body contact recreation category B

Pollutant Identified on the 303(d) List:
Escherichia coli (E. coli) (fecal indicator bacteria)

Identified Sources on 303(d) List:
Rural nonpoint sources

Length and Location of Impaired Segment:
Medicine Creek: 43.8 mi (70.5 km), from Section 9, Township 61N, Range 22W to state line
Little Medicine Creek: 39.8 mi (64.1 km), from mouth to state line

[1] Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS and NRCS 2013). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

[2] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class P streams maintain permanent flow even in drought periods.

[3] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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1. Introduction

A total maximum daily load (TMDL) identifies water quality problems, possible causes of those problems, and provides targets for restoration. However, actual water quality improvements are dependent upon voluntary actions and support from local communities and landowners residing within the watershed. This implementation strategies document is a companion to the TMDL report and provides supplemental information about actions that will implement the goals established in the Medicine Creek and Little Medicine Creek *E.coli* TMDL. These strategies provide a general guide to permit writers, nonpoint source program coordinators, and other Department staff, as well as soil and water conservation districts, local governments, permitted entities, regional planning commissions, watershed managers, and citizen groups for achieving the wasteload and load allocations established in the TMDL. Reducing current pollutant loading to the allocations established in the TMDL will result in the water bodies attaining their designated whole body contact recreational use. In this way, the TMDL serves as a "pollutant diet" for maintaining the environmental health of the streams and protecting the health of those who recreate in its waters. Figure 1 presents the location of the impaired water bodies and their watersheds. The *E. coli* TMDL report for Medicine Creek and Little Medicine Creek is available on the Department's website at dnr.mo.gov/env/wpp/tmdl/619-medicine-cr-623-little-medicine-cr-record.htm. Questions regarding the TMDL may be sent via email to tmdl@dnr.mo.gov or by calling the Department's Watershed Protection Section at 573-751-5723.

This document neither prescribes nor prohibits any specific practices or technologies for reducing bacteria loading in the impaired water bodies and is not intended to serve as the sole means of remediation and restoration. However, the Department recognizes that technical guidance and support are critical to achieving the goals of the TMDL. Therefore, while the TMDL calculates the maximum bacteria loading that the impaired streams can assimilate and still meet water quality standards, this strategies document provides additional information to assist in meeting the TMDL loading goals, including best management practices, potential participants in the watershed, funding sources, and calculations of pollutant reductions.

Because the TMDL addresses bacteria loading from all potential sources in the watershed, this strategies document provides guidance for meeting the established loading targets assigned to both point and nonpoint sources.[4] The Clean Water Act regulates point sources of pollution. Any necessary reductions in bacteria loading from these sources are completed through the Missouri State Operating Permit program. Nonpoint sources of pollution are not regulated through permits and any reductions from these sources will rely on the voluntary implementation of best management practices (BMPs) in the watershed. Local communities and citizens looking to develop organized watershed groups to improve water quality are encouraged to contact the University of Missouri Extension at 573-882-0085. Information regarding the University Extension's water quality program is available online at fsb.missouri.edu/extension/waterquality/.

[4] Point and nonpoint sources are defined and discussed in Sections 5.1 and 5.2 of the Medicine Creek and Little Medicine Creek *E. coli* TMDL.

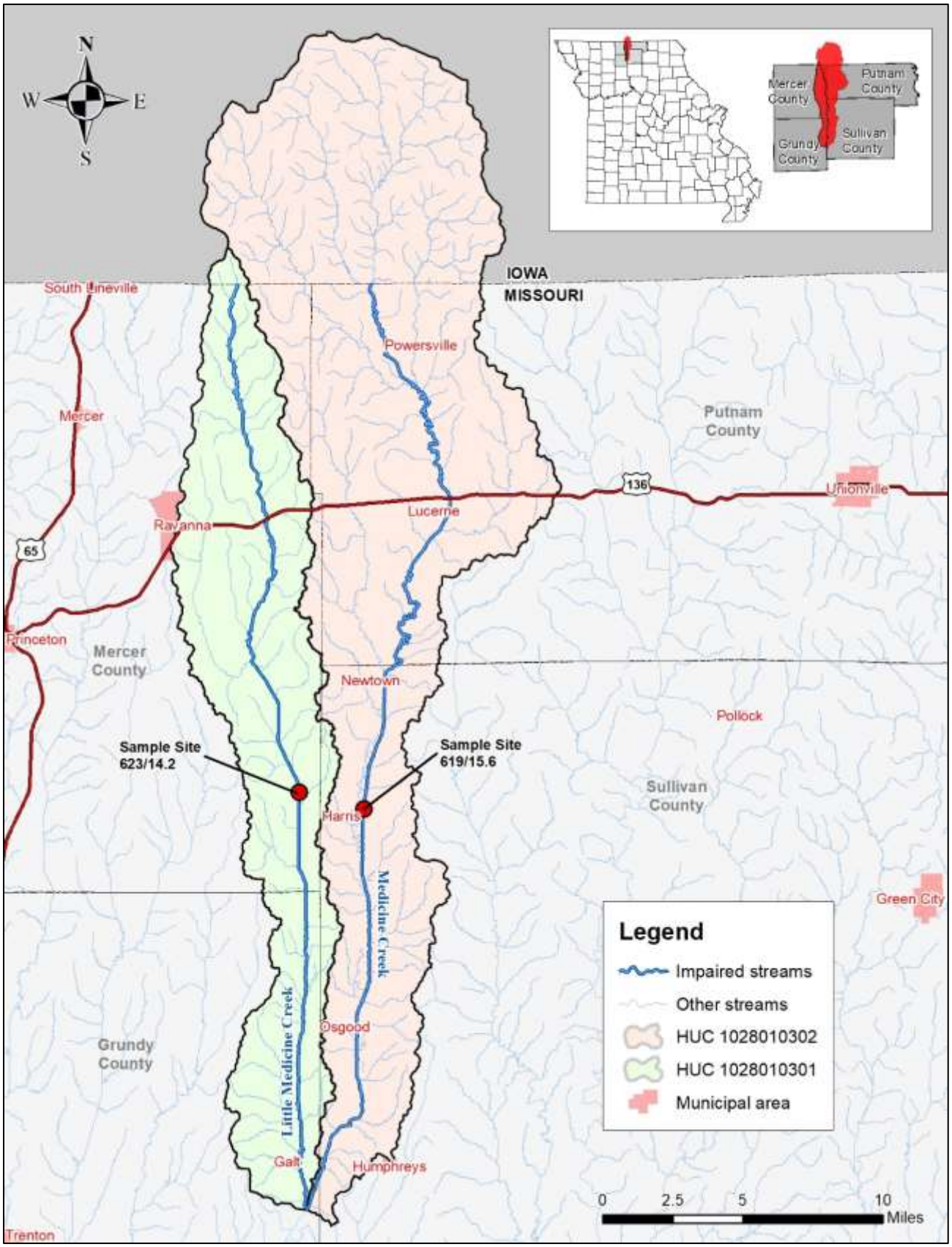

Figure 1. The Medicine Creek (HUC 1028010302) and Little Medicine Creek (HUC 1028010301) watersheds

2. Targeted Participants and Potential Roles in Implementation

The Department implements TMDL targets for point sources through the Missouri State Operating Permit program. For nonpoint sources, private landowners and citizen groups voluntarily implement water quality improving projects and cost-share practices which may be funded in part by grants or subgrants from the Department's Section 319 Nonpoint Source Implementation Program and the Soil and Water Conservation Program. Local governments, citizen groups, and individuals who have an interest in improving water quality in their communities may implement additional water quality improving actions. Successfully meeting the goals of the TMDL requires participation and cooperation from the various parties within the watershed. Participant roles range from technical support to actual on-the-ground implementation of BMPs. Groups and agencies that may potentially be involved in the TMDL implementation process are identified below along with descriptions of their possible roles. This list is not exhaustive and not intended to compel participation from any organizations; nor is it meant to exclude those who are not listed, but may be interested in participating.

- Department of Natural Resources
  - Administers statutory authorities granted by Missouri clean water law
  - Ensures permits issued in the watershed are consistent with the assumptions and requirements of TMDL wasteload allocations (the allowable point source load)
  - Provides compliance assistance to regulated entities
  - Provides technical support to locally-led watershed groups
  - Serves as a potential source of financial assistance for watershed plan development and BMP implementation through Sections 319(h) and 604(b) grants, or through Soil and Water Program cost-share practices
  - Serves as a potential source of financial assistance for infrastructure improvements through low-interest State Revolving Fund loans
  - Assesses attainment of water quality standards on a biennial basis for Clean Water Act Sections 303(d) and 305(b) reporting
  - Provides education and training to volunteers through the Missouri Stream Team Program[5]
- County Soil and Water Conservation Districts
  - Provide financial incentives to agricultural producers to implement conservation practices that help prevent soil erosion and protect water quality
  - Provide technical assistance with design, implementation, and maintenance of conservation practices
- University of Missouri Extension
  - Provides technical assistance for addressing nonpoint source and watershed management issues
  - Assists with organizing locally led watershed groups

[5] The Missouri Stream Team Program is a partnership between the Department of Natural Resources, the Department of Conservation, the Conservation Federation of Missouri, and the citizens of Missouri. The Stream Team Program provides an opportunity for all citizens to get involved in river conservation. Additional information regarding the Stream Team program is available online at mostreamteam.org.

- Missouri Department of Conservation
  - Provides technical assistance with stream and watershed management issues
  - Promotes maintenance and reestablishment of stable streambanks and functional riparian corridors
- Missouri Department of Health and Senior Services
  - Provides technical assistance pertaining to onsite wastewater treatment systems
- County Health Departments
  - Provide technical assistance pertaining to onsite wastewater treatment (i.e., septic) systems
- Municipal and domestic wastewater facilities
  - Disinfect effluent or otherwise comply with applicable *E. coli* permit limits
- Locally led watershed groups
  - Develop and implement Section 319-funded nine key element watershed-based plans.[6] (See Appendix A)
  - Identify critical areas at a local level
  - Implement BMPs
  - Provide public education and outreach
- Stream Team volunteers
  - Collect water quality data through the Volunteer Water Quality Monitoring program (*E. coli* monitoring may be conducted at the Cooperative Stream Investigation level[7])
  - Provide stewardship, advocacy, and education
- Citizens living and working within the watershed
  - Voluntarily implement structural and nonstructural BMPs on private lands, residences, and businesses, such as picking up pet waste, maintaining septic systems, conserving water, controlling erosion, and managing manure

3. Why is a TMDL Needed for Medicine Creek and Little Medicine Creek?

Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations Part 130 require states to develop TMDLs for water bodies not meeting applicable water quality standards. Missouri's Water Quality Standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy. Descriptions of each of these components are located in Section 3 of the TMDL report. Medicine Creek and Little Medicine Creek are not attaining designated whole body contact recreational uses due to *E. coli* bacteria counts exceeding Missouri's numeric criteria. The applicable numeric *E. coli* criterion for Medicine Creek and Little Medicine Creek is 206 counts/100 mL of water during the recreational season (April through October). High counts of *E. coli* are an indication of fecal contamination and an increased risk of pathogen-induced illness. A summary of the available *E. coli* data for the impaired streams is presented in Table 5 of the TMDL report.

[6] Guidance for developing a successful watershed-based plan that incorporates the U.S. Environmental Protection Agency's nine minimum elements is available online at www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters. These nine elements are required for plans funded with incremental Clean Water Act section 319 funds and are recommended for inclusion in all other watershed plans.

[7] More information regarding the Volunteer Water Quality Monitoring, or VWQM, program is available online at dnr.mo.gov/env/wpp/VWQM.htm. Cooperative Stream Investigation (CSI) level monitoring uses EPA approved and accepted analytical methods as well as standard analytical methods developed for the VWQM program. More information regarding the CSI level of training is available on the Department's website at dnr.mo.gov/env/esp/csi.htm.

4. Review of Sources of Bacteria Loading Identified in the TMDL Report

Section 5 of the Medicine Creek and Little Medicine Creek *E. coli* TMDL contains a comprehensive inventory and assessment of all known and suspected sources of bacteria loading in these watersheds. The bacteria sources identified in the TMDL are based on issued permits and a general knowledge of watershed conditions. For some sources, specific loading contributions remain unknown. Groups interested in implementing BMPs in the watershed may want to consider employing microbial source tracking techniques to better identify the primary sources of *E. coli* in their area (i.e., humans, poultry, equine, cattle, domestic pets, or wildlife). However, such techniques can be cost-prohibitive and may be unnecessary if localized land use activities are already well known. More information regarding microbial source tracking techniques is available online from the U.S. Geological Survey at water.usgs.gov/owq/microbial.html. See Table 1 for a list of the potential sources of *E. coli* identified in the TMDL report.

Table 1. Potential sources of *E. coli* loading to Medicine Creek and Little Medicine Creek

Point Sources	Nonpoint Sources

• Municipal and domestic wastewater treatment facilities
  ○ Inadequate treatment or disinfection
  ○ Sanitary sewer overflows
• Concentrated Animal Feeding Operations (CAFOs)
• Illicit straight pipe dischargers
	• Onsite wastewater treatment systems
	• Urban stormwater runoff
	• Agricultural stormwater runoff
	• Natural background conditions (i.e., wildlife)

5. Existing Loads and Needed Reductions

In Figures 10 and 11 of the TMDL report, bacteria loads observed during the recreational season were plotted along the load duration curves. In each of the figures, the y-axis describes bacteria loading as counts per day and the x-axis represents the frequency for which a particular flow is met or exceeded. Lower flows are equaled or exceeded more frequently than higher flows. The flow condition ranges and descriptions presented in the figures illustrate general base-flow and surface-runoff conditions (e.g., high flows, low flows, etc). Moving along the curves from high flows to low flows shows the streams' decreasing assimilative capacities in terms of the expectation that water quality standards are met at the target concentration of 206 counts/100 mL of water. Water quality impairments occur when existing pollutant loading exceeds a water body's assimilative capacity. Pollutant loading to an impaired water body must be reduced if it is to meet water quality standards.

Reducing overall pollutant loading to levels equal to or less than the loading capacities calculated in the TMDL report will result in attainment of water quality standards. These reductions are achieved by point sources reducing loads to meet the calculated wasteload allocation and nonpoint source loading being reduced to meet the load allocation. The TMDL includes a margin of safety that reserves a portion of the load from both point or nonpoint sources in order to ensure that meeting those loading targets will result in attainment of water quality standards. Specific loading reductions needed to meet the loading targets specified in the TMDL are described below.

To maintain a consistent comparison to Missouri's *E. coli* criteria, the geometric means of these observed loads were calculated for each defined flow range. These geometric means represent an estimate of the existing loading occurring under each flow condition during the recreational season (Figures 2 and 3). An estimate of the amount of the existing pollutant load that needs to be reduced at each flow condition can then be determined by calculating the difference between the estimated existing load and the loading capacity. These estimates of existing loading and needed reductions are

provided in Tables 2 and 3. Such loading calculations are required elements for TMDLs and 319-funded watershed-based plans. However, bacteria loads are difficult to relate to real-world reductions observed from BMPs and are not readily comparable to monitoring data collected during implementation. Therefore, concentration reduction targets are provided in Tables 4 and 5.

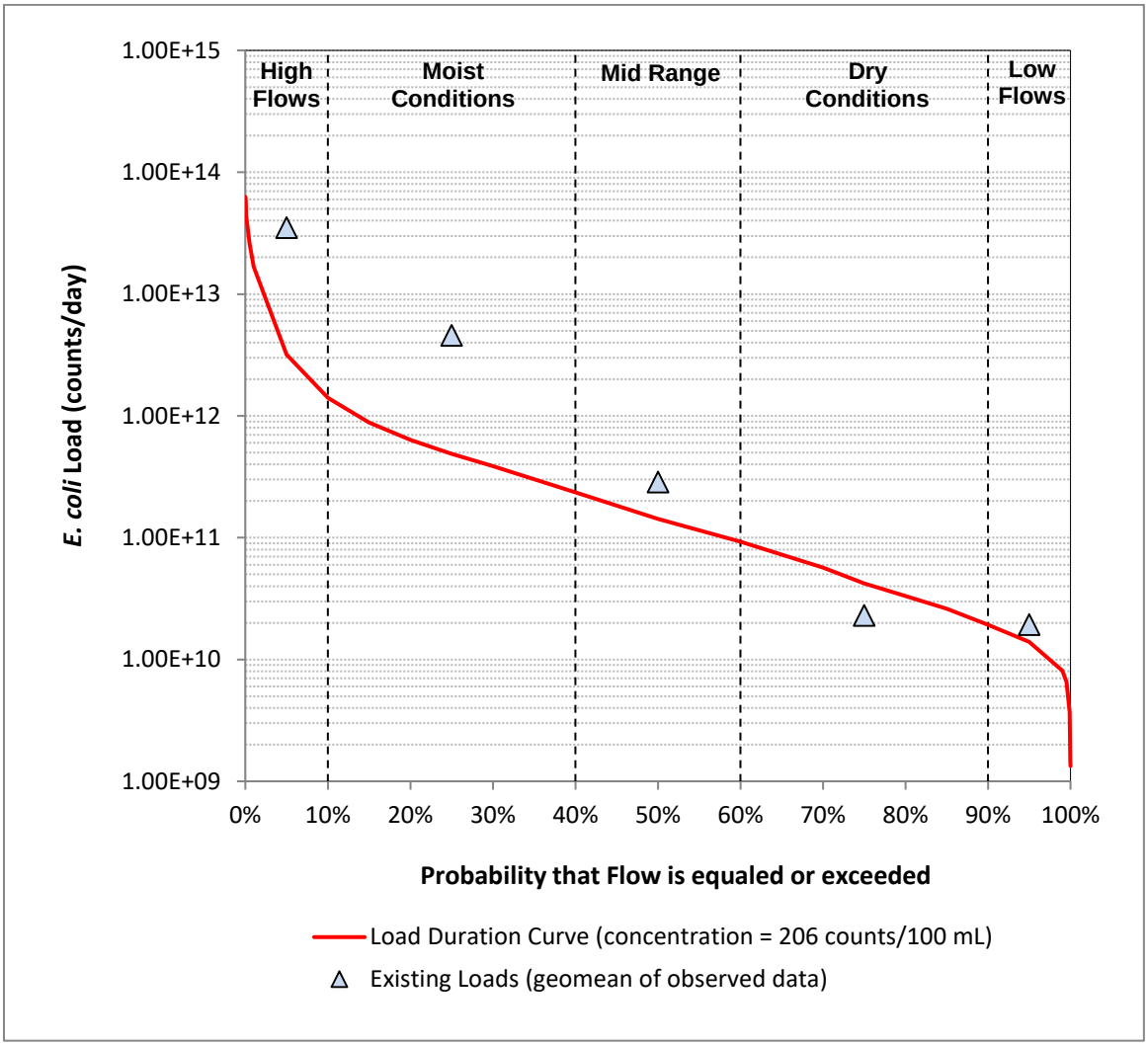

Figure 2. Medicine Creek load duration curve with estimates of existing loading

Table 2. Estimated load reductions needed to attain water quality standards in Medicine Creek

Percent of time flow equaled or exceeded	Flow ft^3/s (m^3/s)	TMDL (counts/day)	Existing Load (counts/day)	Load Reduction Needed (counts/day)	Load Reduction Needed (Percent)
95	2.77 (0.07)	1.39E+10	1.94E+10	5.46E+09	28%
75	8.35 (0.23)	4.21E+10	2.31E+10	0	0%
50	28.24 (0.79)	1.42E+11	2.87E+11	1.45E+11	50%
25	96.77 (2.74)	4.88E+11	4.59E+12	4.10E+12	89%
5	630.49 (17.85)	3.18E+12	3.51E+13	3.19E+13	91%

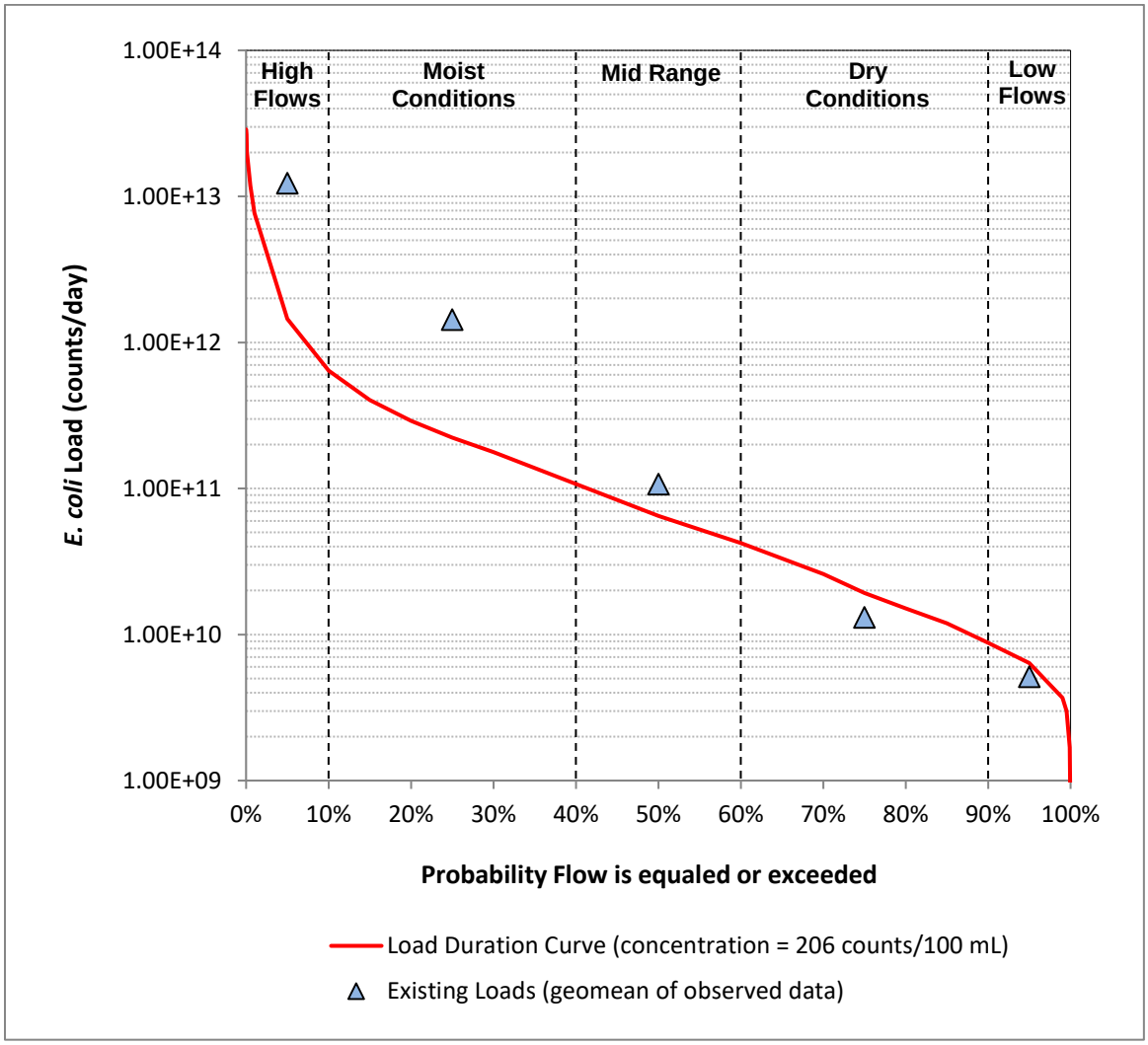

Figure 3. Little Medicine Creek load duration curve with estimates of existing loading

Table 3. Estimated load reductions needed to attain water quality standards in Little Medicine Creek

Percent of time flow equaled or exceeded	Flow ft^3/s (m^3/s)	TMDL (counts/day)	Existing Load (counts/day)	Load Reduction Needed (counts/day)	Load Reduction Needed (Percent)
95	1.26 (0.03)	6.37E+09	5.15E+09	0	0%
75	3.82 (0.10)	1.92E+10	1.32E+10	0	0%
50	12.91 (0.36)	6.51E+10	1.07E+11	4.22E+10	39%
25	44.24 (1.25)	2.23E+11	1.44E+12	1.21E+12	84%
5	288.23 (8.16)	1.45E+12	1.23E+13	1.09E+13	88%

Table 4. Estimated reductions needed to attain water quality standards in Medicine Creek

Percent of time flow equaled or exceeded	Flow ft^3/s (m^3/s)	Water Quality Target (counts/100mL)	Existing Concentration (counts/100mL)	Reduction Needed (Percent)
95	2.77 (0.07)	206	287	28%
75	8.35 (0.23)	206	113	0%
50	28.24 (0.79)	206	416	50%
25	96.77 (2.74)	206	1,939	89%
5	630.49 (17.85)	206	2,276	91%

Table 5. Estimated reductions needed to attain water quality standards in Little Medicine Creek

Percent of time flow equaled or exceeded	Flow ft^3/s (m^3/s)	Water Quality Target (counts/100mL)	Existing Concentration (counts/100mL)	Reduction Needed (Percent)
95	1.26 (0.03)	206	166	0%
75	3.82 (0.10)	206	141	0%
50	12.91 (0.36)	206	340	39%
25	44.24 (1.25)	206	1,328	84%
5	288.23 (8.16)	206	1,750	88%

The reduction estimates provided do not differentiate between point source loading and nonpoint source loading, as the available data are inadequate for estimating pollutant loads or reductions from specific sources. However, assumptions regarding specific sources in the watershed and the flow conditions under which they are likely to contribute loading can aid in watershed planning and selecting appropriate management practices. For example, the highest needed bacteria reductions for Medicine Creek occur during mid-range through high flow conditions, therefore BMPs that address stormwater runoff will address the most significant sources of pollutant loading to this stream. Some exceedance is observed at low flow conditions, which indicates some additional point source controls may be necessary as well as some nonpoint source controls, such as cattle exclusion or onsite wastewater treatment system repairs. During the implementation process, additional water quality monitoring may help determine specific areas, or "hot spots," where significant loading is occurring and where BMPs may be the most effective. Additionally, as discussed in Section 4, microbial source tracking methods may also help groups identify and address specific sources. Groups wishing to develop a monitoring component to any localized implementation plan are encouraged to consult with the Department's Water Quality Monitoring and Assessment Unit, available at 573-522-4505. Other Department monitoring goals for the impaired water bodies are specified within Section 12 of the TMDL report.

6. Implementation of the TMDL

TMDLs provide useful information for setting water quality goals and determining appropriate actions for pollutant reductions. Progress towards meeting water quality standards is expected to be long-term. In general, initial TMDL implementation is typically a continuation of already existing or planned activities, such as permits or Soil and Water Conservation Program cost-share practices. Except in cases where activities and schedules are required by legally binding requirements, such as established permit conditions, an adaptive implementation approach that makes progress toward

achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities should be used.

6.1 Point Source Implementation

Federal regulations at 40 CFR §122.44(d)(1)(vii)(B) require permit conditions to be consistent with the assumptions and requirements of TMDL wasteload allocations. How these conditions are expressed can vary depending upon the pollutant and nature of the discharge. Although TMDLs are required to be written for daily time increments, permit effluent limits may be written in a form that derives from and complies with applicable water quality standards that use any time measure (40 CFR 122.44(d)(1)(vii)(A) and EPA 2006). The Department's permit writers have discretion for how TMDL wasteload allocations are expressed in a permit and for determining appropriate implementation schedules. Permit writers should consult available permit writing handbooks and technical support documents to determine appropriate limits.[8] Although wasteload allocations are often specified for individual facilities, in some cases, it may be appropriate for pollutant loadings to be shifted between the individual facilities during permitting as long as the sum of the wasteload allocations remains unchanged and is not exceeded (EPA 2012). In no case does a TMDL wasteload allocation allow for permit limits that exceed water quality standards. If water quality standard revisions result in criteria more stringent than an established TMDL wasteload allocation, then the more stringent criteria should be used in deriving the permit limits.[9] Information regarding the Department's permitting process is available online at dnr.mo.gov/env/wpp/permits/index.html or by calling the Department's Operating Permit Section at 573-522-4502. Table 6 lists the types of point sources in the Medicine Creek and Little Medicine Creek watersheds that should be addressed in order to achieve the TMDL wasteload allocation targets. As noted in the TMDL, three municipal wastewater discharges are present in these watersheds that are potential contributors of bacteria loading. Currently none of the three facilities disinfect their effluent, however appropriate *E. coli* limits or schedules of compliance are provided in state operating permits (See Table 6 of TMDL).

Table 6. TMDL implementation for point sources in the Medicine and Little Medicine watersheds

Type	Objective	Strategies
Municipal and domestic wastewater dischargers	Meet wasteload allocations assigned in Section 8.1 of the TMDL report	• Appropriate *E. coli* permit limits • Disinfection • Consider no discharge options • Reduce occurrences of sanitary sewer overflows
Concentrated Animal Feeding Operations (CAFOs)	Meet wasteload allocations assigned in Section 8.3 of the TMDL report	• Maintain no discharge • Land apply waste according to permitted conditions • Nutrient management plans to manage manure application rates
Illicit straight pipe discharges	Illegal discharges and therefore should be eliminated from the watershed	• Report known discharges to local county health departments

[8] The Department maintains a Water Pollution Control Permit Manual to provide guidance to permit writing staff and is available online at dnr.mo.gov/env/wpp/permits/manual/. Additionally the EPA maintains a National Pollutant Discharge Elimination System (NPDES) Permit Writers' Manual online at epa.gov/npdes/npdes-permit-writers-manual and a FAQ document for water quality-based permitting for protecting recreational uses at epa.gov/npdes/npdes-water-quality-based-permit-limits-recreational-water-quality-criteria-0

[9] Federal regulations at 40 CFR 131.21, also known as the "Alaska Rule," require water quality standards to be approved by the EPA before they can be used for Clean Water Act purposes (i.e., water quality-based effluent limitations or TMDLs).

6.2 Nonpoint Source Implementation

The Department does not regulate nonpoint sources through permits. Nonpoint source loading is reduced using voluntary BMPs to improve land use practices that may be contributing bacteria to the impaired water bodies. Nonpoint source load reductions can be achieved at any location in the watershed; however targeted projects by locally led watershed groups and local governments using a nonpoint source watershed-based plan may be more effective in restoring water quality. The Department supports the development and implementation of nonpoint source watershed-based management plans through competitive EPA funded subgrants. More information about the Department's Section 319 Nonpoint Source Implementation Program is available online at dnr.mo.gov/env/swcp/nps/index.html or by calling 573-751-4932.

As discussed in Section 5.2 of the TMDL report, nonpoint sources identified as potential contributors of bacteria loads in the Medicine Creek and Little Medicine Creek watersheds include stormwater runoff from both urban and agricultural areas and onsite wastewater treatment systems. Nonpoint sources primarily contribute bacteria loads from contaminated stormwater runoff and the erosion of bacteria contaminated sediments at flows influenced by precipitation events. To meet target load allocations, BMPs that reduce runoff and surface erosion are the primary means for achieving load reductions from nonpoint sources. However, failing onsite wastewater treatment systems and direct waste inputs from animals that are not excluded from waterways can contribute bacteria loads under dry conditions. Therefore, BMPs that reduce nonpoint source loading from these types of sources at lower flows may also help the impaired streams attain water quality standards.

6.2.1 Agricultural Stormwater Runoff

Background: As noted in Section 5.2.1 of the TMDL report, stormwater runoff from agricultural lands, such as pastures used for livestock grazing or cropland fertilized with animal manure, may contribute bacteria loads to waters in the Medicine Creek and Little Medicine Creek watersheds. Land cover data provided in Section 5.2.5 of the TMDL report indicate that agricultural practices occurring within riparian corridors may be areas of special concern as influences to surface water quality may be more directly impacted.

Objective: Bacteria loading from agricultural runoff is a component of the TMDL load allocation. The implementation of BMPs that reduce soil erosion or the movement of manure fertilizers from application sites will provide the greatest benefits in reducing bacteria loading from agricultural lands. Additionally, minimizing or eliminating livestock accessibility to streams can also reduce nonpoint source bacterial loads by reducing waste from being deposited directly into the waterway. Installing BMPs on highly responsive areas may produce the greatest benefit to water quality (Figure 4). The information provided by this map should be supplemented with local knowledge of the watershed in order to identify "critical areas" for BMP implementation and Section 319 funding. Until such time when critical areas have been identified, priority for BMP implementation should be given to areas identified as being highly responsive and that are within the riparian corridors of streams in the Medicine Creek or Little Medicine Creek watersheds. Appendices A and B present additional maps of highly responsive areas in the Medicine Creek and Little Medicine Creek watersheds at a subwatershed scale.[10]

[10] Subwatersheds are based on 12-digit HUC boundaries

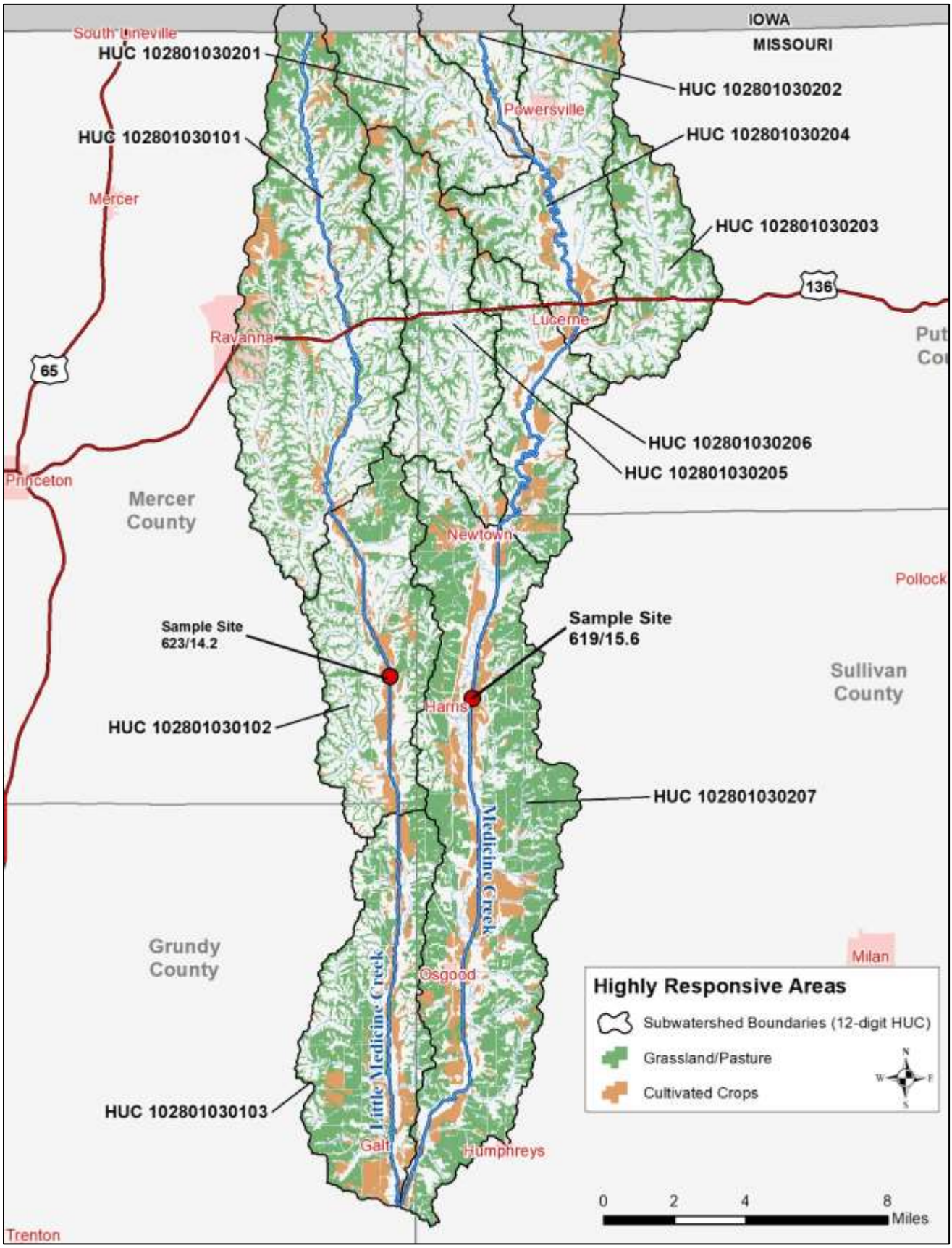

Figure 4. Agricultural areas likely to be highly responsive to BMP implementation

Strategy 1: In Missouri, the Soil and Water Conservation Program provides assistance and cost sharing opportunities to farmers and landowners willing to implement practices designed to, among other things, address grazing systems, animal waste management, soil erosion, and the protection of water quality. An online directory of the soil and water conservation districts in Missouri is available at http://mosoilandwater.land/. Table 7 presents a list of available cost-share conservation practices that may reduce bacteria loading to surface waters. Table 8 presents a list of those cost-share practices implemented within the Medicine Creek and Little Medicine Creek watersheds since 2012.

Table 7. Soil and Water Conservation Program Cost-Share Practices that may reduce *E. coli* loading

Cost-Share No.	Practice	Mode of Action		
		Avoid	Control	Trap
DSL-01	Permanent Vegetative Cover Establishment	x	x	x
DSL-02	Permanent Vegetative Cover Improvement	x	x	x
DSL-111	Permanent Vegetative Cover –Confined Animal Feedlot	x	x	x
N340	Cover Crop	x	x	x
N585	Contour Stripcropping		x	x
DSP-02	Permanent Vegetative Cover Enhancement	x	x	x
DSP 3.1	Grazing System Water Development		x	
DSP 3.2	Grazing System Water Distribution		x	
DSP 3.3	Grazing System Fence	x	x	
DSP 3.5	Grazing System Seed	x	x	x
N312	Beef Waste Management System	x	x	
N312	Dairy Waste Management System	x	x	
N312	Poultry Waste Management	x	x	
N312	Swine Waste Management	x	x	
N316	Incinerator	x	x	
N317	Composting Facility	x	x	
N590	Nutrient Management	x	x	
C650	Streambank Stabilization		x	x
DSP-31	Sinkhole Improvement		x	x
BDSP-31	Buffer Sinkhole Improvement		x	x
N351	Well Decommissioning	x		
N386	Field Border		x	x
N393	Filter Strip		x	x
N574	Spring Development	x		
N725	Sinkhole Treatment	x	x	x
WQ10	Stream Protection	x	x	x
N472	Livestock Exclusion	x		

Table 8. Implemented Soil and Water Conservation Program Cost-Share Practices 2012 - 2018

Watershed	12-digit HUC	County	Cost-Share No.	No. of Practices	Extent Installed
Medicine Creek WBID 619	102801030203	Putnam	DSL-01	1	15.00 acres
	102801030203	Putnam	N340	1	87.52 acres
	102801030205	Mercer	DSL-01	1	28.40 acres
	102801030207	Sullivan	DSL-01	2	65.40 acres
	102801030207	Sullivan	N351	1	1 unit
	102801030207	Sullivan	N472	6	9.20 acres
Little Medicine Creek WBID 623	102801030101	Mercer	DSL-01	5	114.00 acres
	102801030101	Mercer	N340	3	270.10 acres
	102801030102	Mercer	DSL-01	1	34.60 acres
	102801030103	Sullivan	N351	1	1 unit

Strategy 2: Any voluntary BMP that is implemented to control erosion or limit the movement of animal manure from agricultural land can aid in the reduction of bacteria loading to surface waters. Table 9 presents examples of common BMPs that address agricultural runoff and where they may be used. Some of these BMPs may be similar or the same as those available through the cost-share program. BMPs placed in locally identified critical areas or in the highly responsive areas identified in this document will provide the greatest water quality benefits.

Table 9. BMPs to address agricultural runoff in the Medicine and Little Medicine watershed

Best Management Practice	***Description***	***BMP-Type***
Cover crops	Vegetation planted to reduce surface erosion after harvest until the next crop	Cropland
Nutrient management plans	A plan to manage the amount, placement, and timing of applications of manure fertilizers	Cropland
Conservation crop rotation	Various crops grown on the same land in a planned rotation, which reduces erosion	Cropland
Grassed waterways	A grassed strip to convey water and prevent gully formation	Cropland
Terraces	An earth embankment across the slope of a field to intercept runoff and trap soil	Cropland
Vegetative Buffers	Permanently vegetated areas that reduce sediment loss	Cropland
Water retention structures	Structures to control runoff and prevent erosion	Cropland
Off-stream watering systems	Livestock watering systems located away from streams or ponds, which reduces the time livestock spend in a stream	Livestock
Rotational grazing	Rotating livestock within a pasture to spread manure more uniformly and allows vegetation to rest and regenerate	Livestock
Relocate pasture feeding sites	Move feeding sites away from streams to reduce manure near stream	Livestock

Grazing management plans	A plan designed to avoid over grazing, and subsequent erosion	Livestock
Relocate feeding pens	Move feeding pens away from streams to reduce manure near stream	Livestock
Fence off streams and ponds	Prevent livestock from entering water ways	Livestock
Vegetative filter strips	Vegetated areas that receive runoff from crop and animal operations	Livestock

6.2.2 Urban Stormwater Runoff (Unregulated)

Background*:* Stormwater runoff from developed areas where impervious surfaces are common may contribute bacteria loads to surface waters.

Objective: Bacteria loading contributions from urban runoff are considered within the aggregated load allocation for nonpoint sources. Due to the small proportion of developed land in the watershed, the TMDL does not anticipate the need to reduce bacteria loading from these areas to meet the specified loading targets. Nevertheless, strategies employed to maintain loading to existing levels are encouraged. Riparian areas adjacent to urban development are especially susceptible to risks of degradation and should be specifically targeted for any BMP implementation to reduce erosional impacts and inputs from stormwater runoff.

Strategy 1*:* Reducing overall stormwater inputs into surface waters can help reduce bacteria loading. Various BMPs and green infrastructure options exist for increasing stormwater infiltration into the ground and reducing stormwater runoff. BMP selection will be dependent upon site location, community needs, and available funding. The EPA maintains resources for urban stormwater management and green infrastructure on its website at epa.gov/green-infrastructure/community-solutions-stormwater-management-guide-voluntary-long-term-planning. Likewise, the Department maintains the *Missouri Guide to Green Infrastructure* online at dnr.mo.gov/env/wpp/stormwater/mo-gi-guide.htm.

Strategy 2: Although general reductions in stormwater are expected to aid in reducing pollutant loading, BMPs designed to address the specific pollutant of concern should be considered. Although few urban BMPs are designed to directly target bacteria, the International Stormwater BMP Database, available online at bmpdatabase.org, provides information about various BMP efficiencies for reducing specific pollutants, including bacteria. BMPs that significantly decrease of bacteria loads include bioretention, retention ponds, and wetland basins (Table 10).

Table 10. Influent/Effluent Summary for BMPs with a statistically significant decrease in *E. coli*

BMP Type	# of Studies		25th Percentile (counts/100mL)		Median (counts/100mL)		75th Percentile (counts/100mL)	
	In	Out	In	Out	In	Out	In	Out
Bioretention	4	4	44	6	290	101	2,400	2,400
Retention Ponds	4	4	582	10	2,063	100	5,500	697
Wetland Basin	5	5	383	88	1,369	637	7,169	2,376
Retention Pond + Wetland Basin	9	9	403	36	1,713	311	6,100	1,300

(Source: bmpdatabase.org 2014)

Strategy 3: Non-structural BMPs can also aid in reducing bacteria loads from urban runoff. Proper collection and disposal of waste from domestic pets or backyard livestock (e.g., horses) reduces the potential for stormwater runoff to be exposed to *E. coli* contaminated substances. Education and outreach regarding this subject can result in behavioral changes that will aid in reducing *E. coli* loading to surface waters. General steps that can be taken to reduce *E. coli* loading from domestic pets or backyard livestock include:

- Always pick up after animals and dispose of their waste properly;
- Encourage others to pick up after their pets;
- Prevent animal wastes from entering storm drains;
- Develop a storm drain marking program to increase awareness of where pet wastes and runoff go when not disposed of properly; and
- Avoid walking pets or horseback riding near streams and other waterways.

6.2.3 Onsite Wastewater Treatment Systems

Background: Failing onsite wastewater treatment systems (e.g., septic systems) may be sources of bacteria to nearby waterways during periods associated with either wet weather or dry weather flows depending upon the nature of the failure.

Objective: By design, properly functioning onsite wastewater treatment systems should not be contributing significant bacteria loads to surface waters. For this reason, the TMDL assigns a load allocation of zero to these potential sources. Proper maintenance of onsite wastewater treatment systems including septic tanks, associated drain fields, and household lagoons is the primary BMP for limiting bacterial inputs from these sources.

Strategy 1: Educate homeowners about proper onsite wastewater treatment system maintenance. This may be provided by local governments, local watershed groups, or university extension offices. The EPA maintains various guidance documents and resources pertaining to onsite treatment systems including the *Homeowner's Guide to Septic Systems* online at water.epa.gov/infrastructure/septic/homeowner-resources.cfm. For onsite wastewater treatment systems that are already failing, repair or replacement of the system is necessary.

Strategy 2: Any local ordinances regarding permitting requirements pertaining to repairs, replacement or the installation of new systems must be followed.

Strategy 3: Consideration should be given to reducing reliance on onsite systems in favor of centralized systems. Homeowners and local governments should explore the potential elimination of onsite systems and connection to existing sewer systems. Elimination of any onsite wastewater treatment systems in the watershed is expected to result in reductions of bacteria loading.

7. Costs of Implementation and Potential Funding Sources

TMDLs are written to meet applicable water quality standards per federal regulations at 40 CFR 130.7(c)(1). As a result, they are developed without considerations of cost or available treatment technologies. However, facility upgrades and BMP installations result in real-world costs that need to be considered before determining what technologies or actions to employ in order to meet the calculated water quality targets. In many cases, TMDL implementation is partially a continuation of already permitted activities and costs are incurred as part of the normal operation and maintenance of

those permitted systems. Other point source costs may arise as a result of needed facility upgrades, such as the installation of disinfection technology, in order to meet specified permit limits or conditions. For nonpoint sources, costs associated with installing and maintaining BMPs or with the maintenance, repair, or replacement of onsite wastewater treatment systems depend upon the type, number, and complexity of the practice or repair. Fortunately, a single BMP may address several pollutants or degradation pathways, thereby compensating for the overall costs by providing additional water quality benefits. Estimates of BMP costs are available online from the International Stormwater BMP Database at bmpdatabase.org.

To offset costs associated with facility upgrades or BMP implementation, a variety of grants and loan programs are available to assist watershed stakeholders. The most commonly used sources of funding are low-interest loans through the State Revolving Fund, Section 319 subgrants, and cost-share practices through the state's Soil and Water Conservation Program.

Low-interest loans from the Clean Water State Revolving Fund are available through the Department's Water Protection Program Financial Assistance Center. The State Revolving Fund provides subsidized loans to municipalities, counties, public sewer districts, and political subdivisions for wastewater infrastructure projects. Loans may be paired with grant funds for qualifying communities. Information on the Department's grant policy is available online at dnr.mo.gov/env/wpp/srf/wastewater-assistance.htm. Eligible projects include new construction or improvement of existing facilities. More information regarding the State Revolving Fund Program is available online at dnr.mo.gov/env/wpp/srf/index.html.

The Missouri Agricultural and Small Business Development Authority (MASBDA) offers an Animal Waste Treatment System Loan Program in cooperation with the Clean Water State Revolving Fund. Animal Waste Treatment Loans Program may finance eligible animal waste treatment systems for independent livestock and poultry producers with operations of less than 1,000 animals. Eligible costs include storage structures, land, dedicated equipment, flush systems, composters, and more. More information regarding the Animal Waste Treatment Loans Program is available online at agriculture.mo.gov/abd/financial/awloanprg.php.

By amendment to the federal Clean Water Act in 1987, the Section 319 grant program was established to provide funding for efforts to reduce nonpoint source pollution. EPA provides 319 funding to the state, which in turn allocates a portion of the funding as subgrants to public and non-profit organizations to address nonpoint source concerns. Section 319-funded subgrants may be used to demonstrate innovative BMPs, support education and outreach programs, restore impaired waters, or protect waters from becoming impaired. More information regarding the Section 319 Nonpoint Source Implementation Program is available online at dnr.mo.gov/env/swcp/nps/index.html.

The Soil and Water Conservation Program provides financial incentives to landowners to implement practices that help prevent soil erosion and protect water quality. The program offers cost-share practices through its county conservation districts. Landowners may receive up to 75 percent reimbursement of the estimated cost of a practice through the program. The primary funding for cost-share practices from the Soil and Water Conservation Program comes from the one-tenth-of-one percent Parks, Soils and Water Sales Tax. More information regarding the Soil and Water Conservation Program and cost-share practices is available online at dnr.mo.gov/env/swcp/service/swcp_cs.htm.

In addition to state sources of funding, federal assistance, public bonds, and private financing may also be available for TMDL implementation. For example, the U.S. Department of Agriculture through its Natural Resources Conservation Service provides various incentive and financial assistance programs for implementing BMPs that reduce pollutant loading from agricultural areas. Additionally, the EPA maintains the Catalog of Federal Funding, which is a searchable database for other financial assistance sources. Table 11 provides links to these as well as other federal funding sources.

Table 11. Online resources for potential funding sources

Name and URL	***Description***
U.S. Department of Agriculture Natural Resources Conservation Service https://www.nrcs.usda.gov/wps/portal/nrcs/site/mo/home/	Financial assistance and incentives to implement voluntary BMPs º Environmental Quality Incentives Program (EQIP) º Regional Conservation Partnership Program (RCPP) º Conservation Stewardship Program (CSP) º Agricultural Conservation Easement Program (ACEP)
Catalog of Federal Funding https://www.epa.gov/waterdata/catalog-federal-funding	Searchable database for financial assistance sources
Nonpoint Source – Related Funding Opportunities http://water.epa.gov/polwaste/nps/funding.cfm	List of federal websites with information regarding funding opportunities
Environmental Education Grants http://www2.epa.gov/education/environmental-education-ee-grants	Financial support for environmental education projects
Environmental Justice Grants https://www.epa.gov/environmentaljustice/environmental-justice-grants-and-resources	Grant resources for Environmental Justice communities
Water Infrastructure and Resiliency Finance Center https://www.epa.gov/waterfinancecenter	Provides financing information for drinking water, wastewater and stormwater decisions
Grants.gov http://www.grants.gov	A common website for federal agencies to post funding opportunities

8. Measurable Goals, Timeline, and Milestones

TMDL implementation uses an adaptive management process that makes progress toward achieving water quality goals while using any new information to reduce uncertainty and adjust implementation activities. Timelines and interim milestones for reaching goals are adjustable and vary depending upon the means of implementation, as well as the strategies used to address individual point or nonpoint sources.

8.1 Point Source Implementation

When appropriate, federal regulations at 40 CFR §122.47 allow a permit to specify a schedule of compliance. Any schedule of compliance included in a permit for meeting final *E. coli* effluent limits, installing disinfection technologies, or other relevant requirements will serve as the primary timeline and goals for implementing the TMDL as it pertains to point source dischargers. If applicable, any

schedules identified in compliance agreements, court orders, or other enforcement actions will also serve as a timeline for point source TMDL implementation.

8.2 Nonpoint Source Implementation

The inclusion of timelines, milestones, and measurable goals is a required element for watershed-based plans developed with Section 319 funding and support. Any 319-funded watershed-based management plans developed for the Medicine Creek or Little Medicine Creek watersheds or any subwatersheds therein should incorporate the goals established in the approved TMDL. These plans should also contain various milestones and implementation goals for conservation practices, as well as educational targets. Once developed, the schedules outlined in those plans will serve as a schedule for TMDL implementation as it pertains to nonpoint sources.

9. Conclusion

The purpose of this TMDL implementation strategies document is to serve as a general guide to Department staff, soil and water conservation districts, local governments, permitted entities, watershed managers, and citizen groups for reducing existing bacteria loads in order to meet the loading targets established in the Medicine Creek and Little Medicine Creek *E. coli* TMDL. The ultimate goal is to restore the bacteria impaired water body segments to conditions that meet water quality standards. Implementation should follow an adaptive implementation approach that makes progress toward achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities. Implementation efforts are expected to occur over a number of years, but within the schedules established in state operating permits and Section 319 watershed-based plans. Success in achieving water quality standards will be determined by the Department through biennial assessments of water quality compliance as required by Sections 305(b) and 303(d) of the Clean Water Act.

The Department has an administrative record on file for the Medicine Creek and Little Medicine *E. coli* TMDL. The record contains this implementation strategies document, the TMDL report, and any studies, data or calculations on which the TMDL is based. This information is available upon request to the Department at dnr.mo.gov/sunshine-form.htm. Any request for information about this TMDL will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the Department's administrative policies and procedures governing Sunshine Law requests. For more information about open record/Sunshine requests, please consult the Department's website at dnr.mo.gov/sunshinerequests.htm.

This implementation strategies document is scheduled for a 45-day public notice and comment period in conjunction with the comment period for the Medicine Creek and Little Medicine Creek *E. coli* TMDL. Any comments received, as well as the Department's responses to those comments, will be maintained on file with the Department and posted online at dnr.mo.gov/env/wpp/tmdl/619-medicine-cr-623-little-medicine-cr-record.htm. The Department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities. Those interested in subscribing to these TMDL updates can submit their email address using the online form at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

10. References

bmpdatabase.org. 2014. International Stormwater Best Management Practices (BMP) Database Pollutant Category Statistical Summary Report. [Online WWW] Available URL: www.bmpdatabase.org/performance-summaries.html [Accessed 22 May 2018]

EPA (U.S. Environmental Protection Agency). 2012. Draft Considerations for Revising and Withdrawing TMDLs. [Online WWW] Available URL: www.epa.gov/tmdl/draft-considerations-revising-and-withdrawing-tmdls [Accessed 22 May 2018]

Appendix A
Nine Key Elements Critical to a Watershed Management Plan

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan, as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Appendix B
Medicine Creek Subwatersheds
Maps of Areas Highly Responsive to BMP Implementation[11]

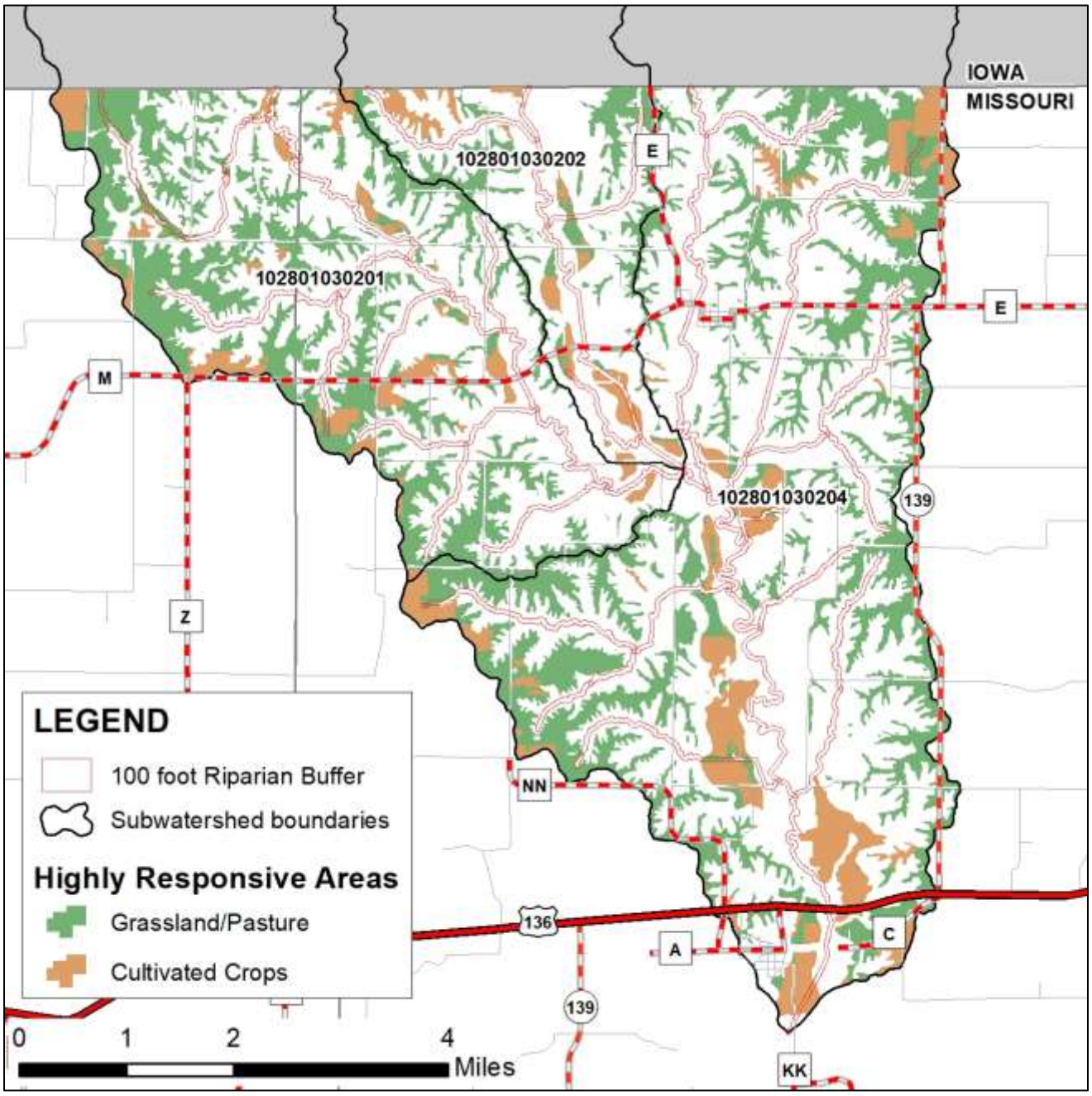

Figure A1. 12-digit HUCs 102801030201, 102801030202, and 102801030204

[11] For all maps, the top of the map is north.

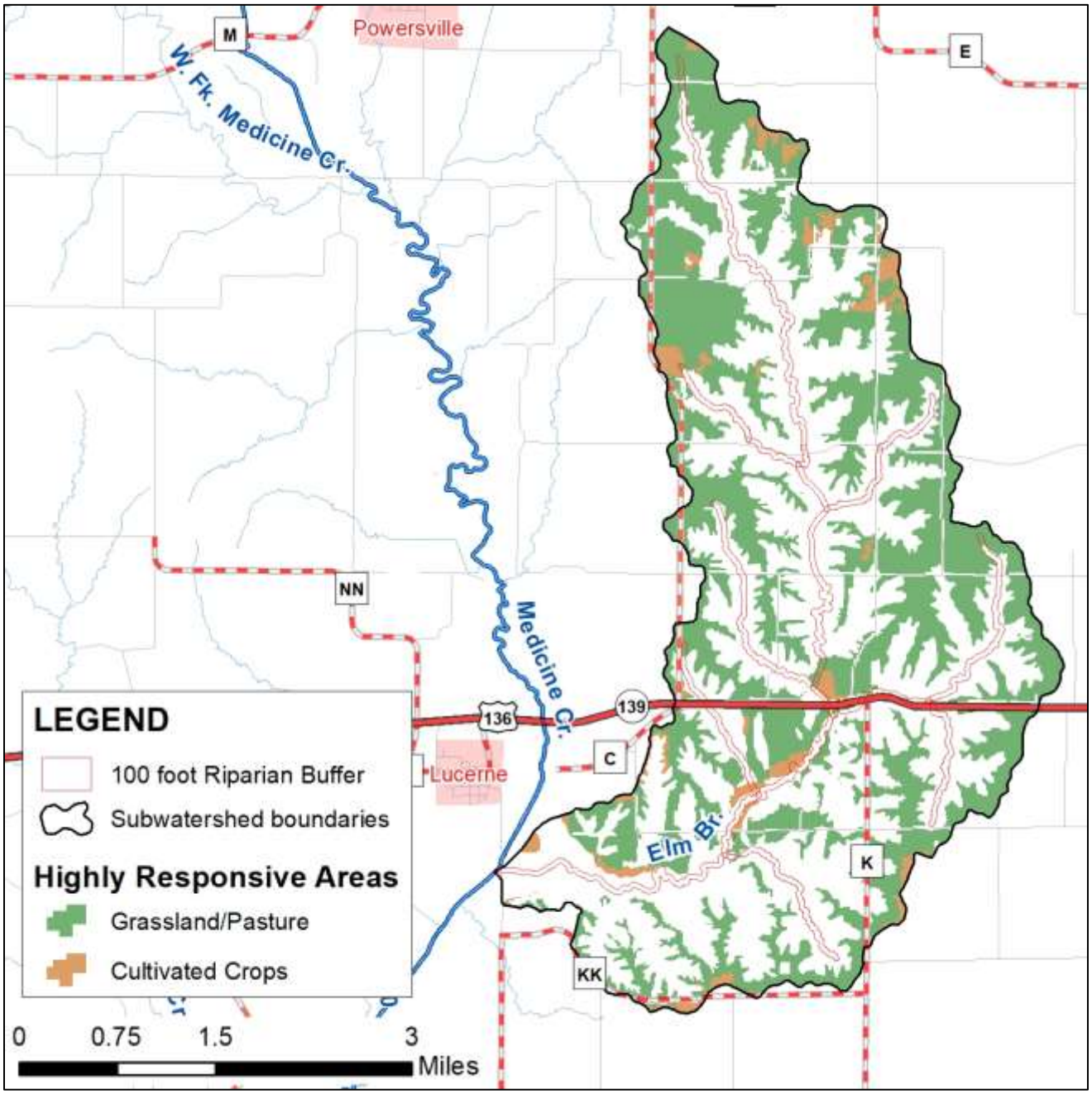

Figure A2. 12-digit HUC 102801030203

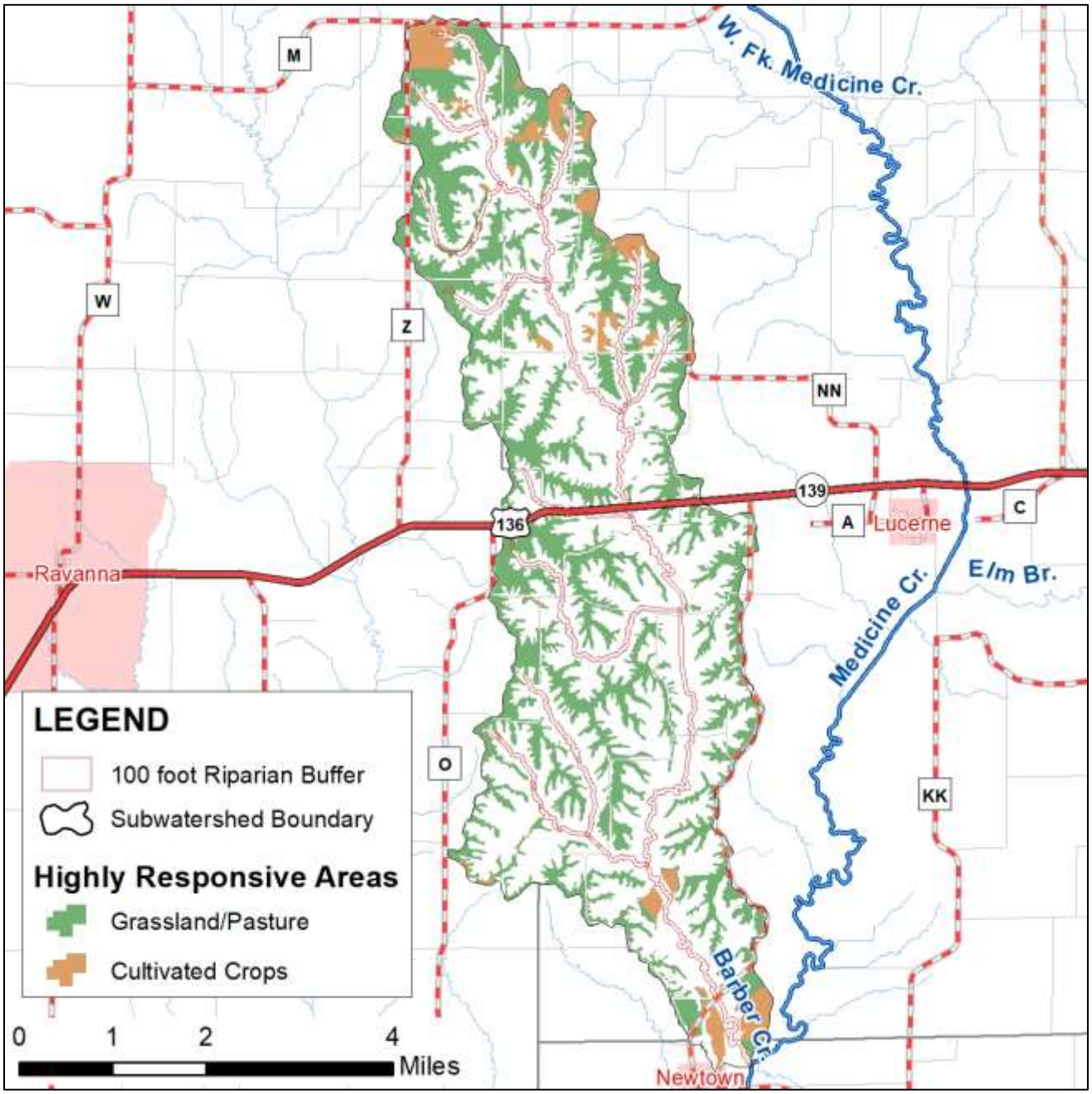

Figure A3. 12-digit HUC 102801030205

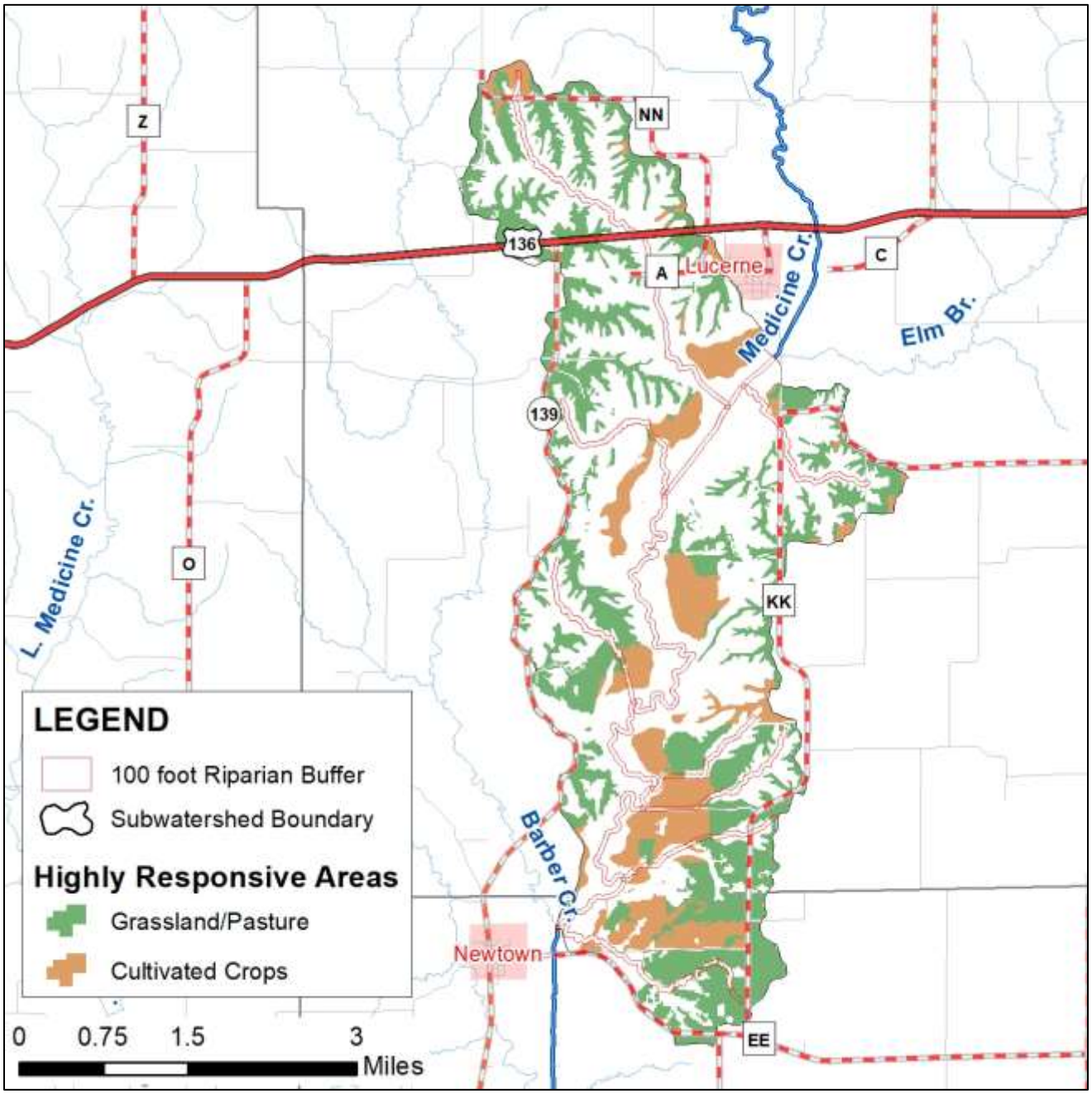

Figure A4. 12-digit HUC 102801030206

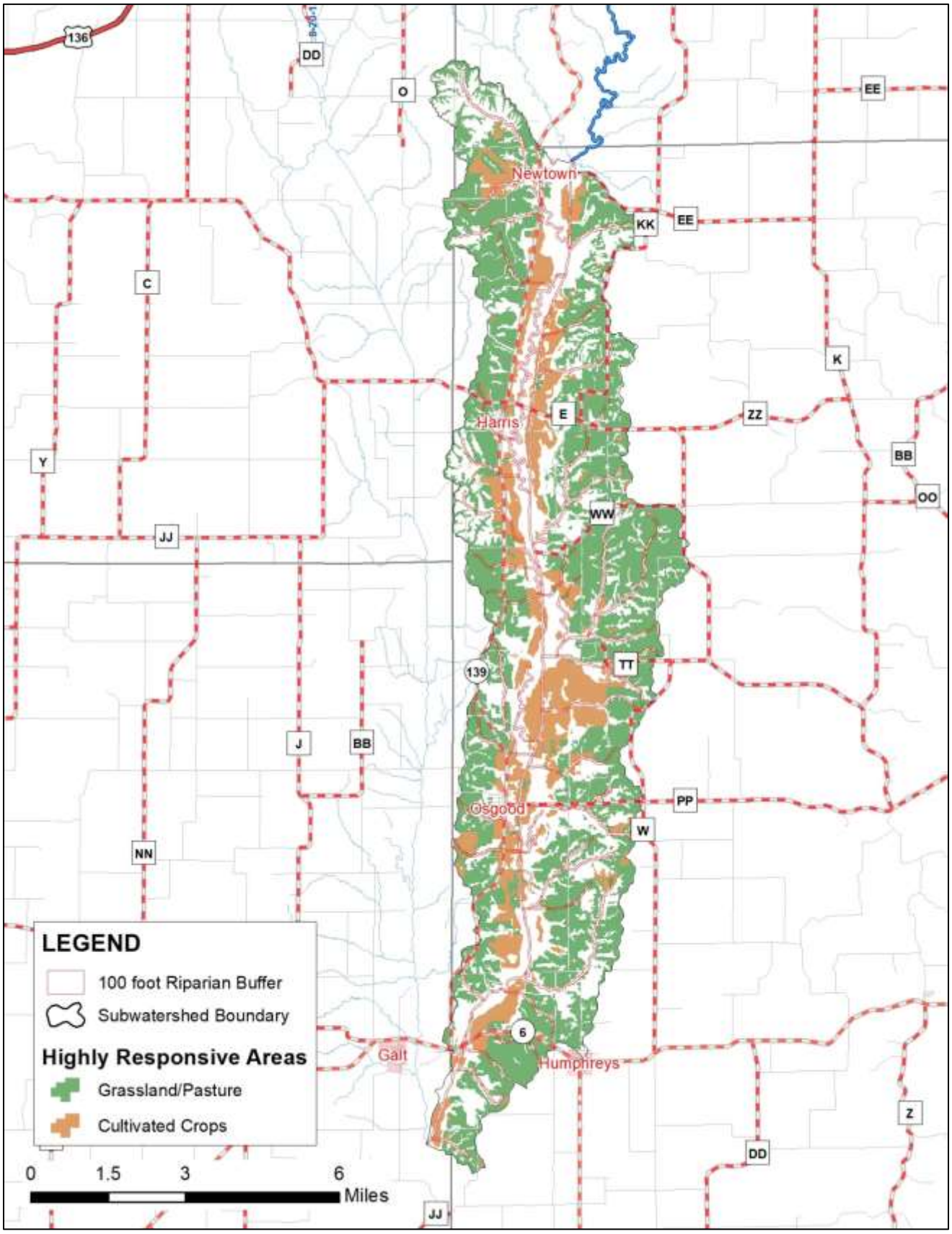

Figure A5. 12-digit HUC 102801030207

Appendix C
Little Medicine Creek Subwatersheds
Maps of Areas Highly Responsive to BMP Implementation[12]

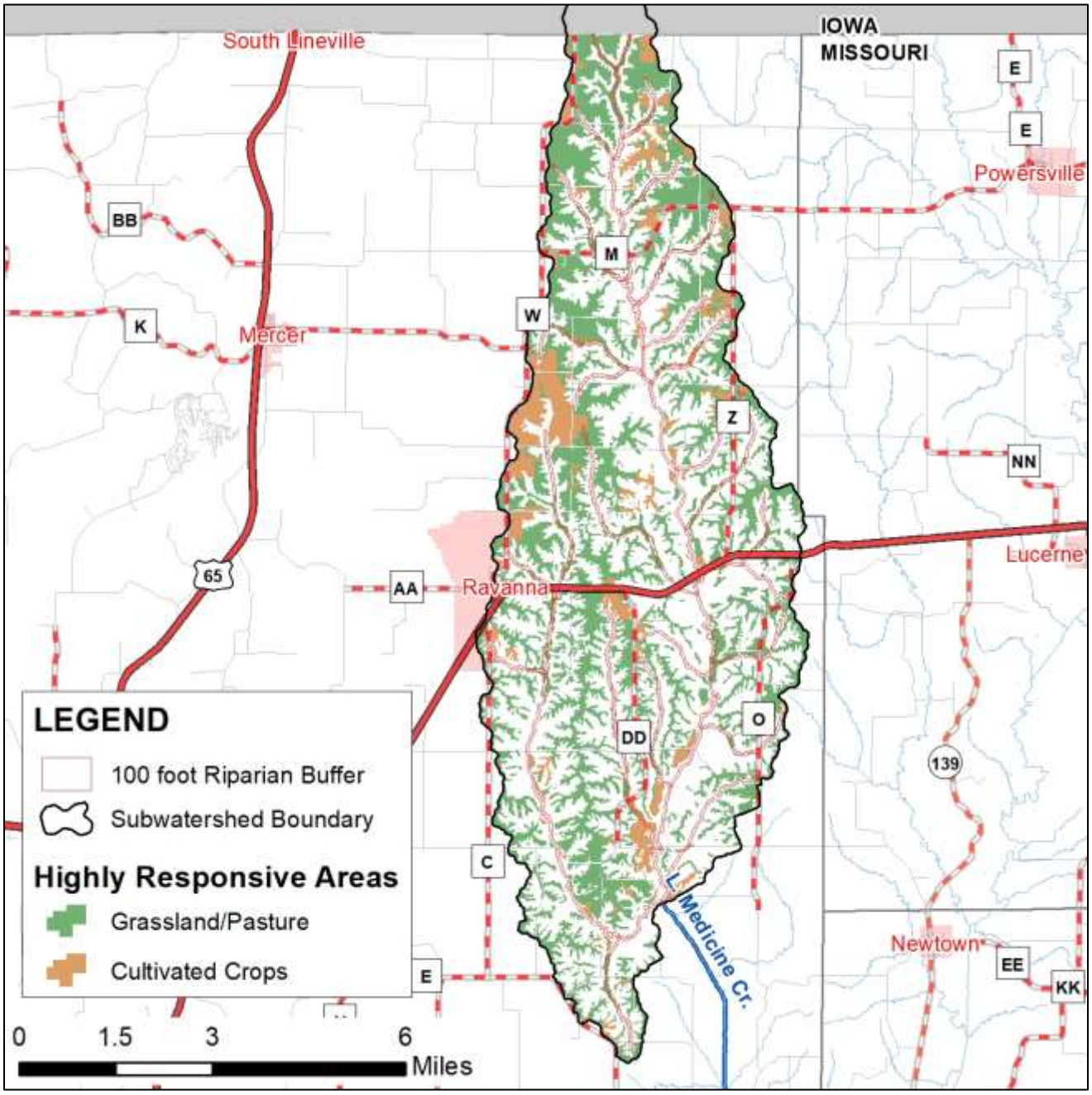

Figure B1. 12-digit HUC 102801030101

[12] For all maps, the top of the map is north.

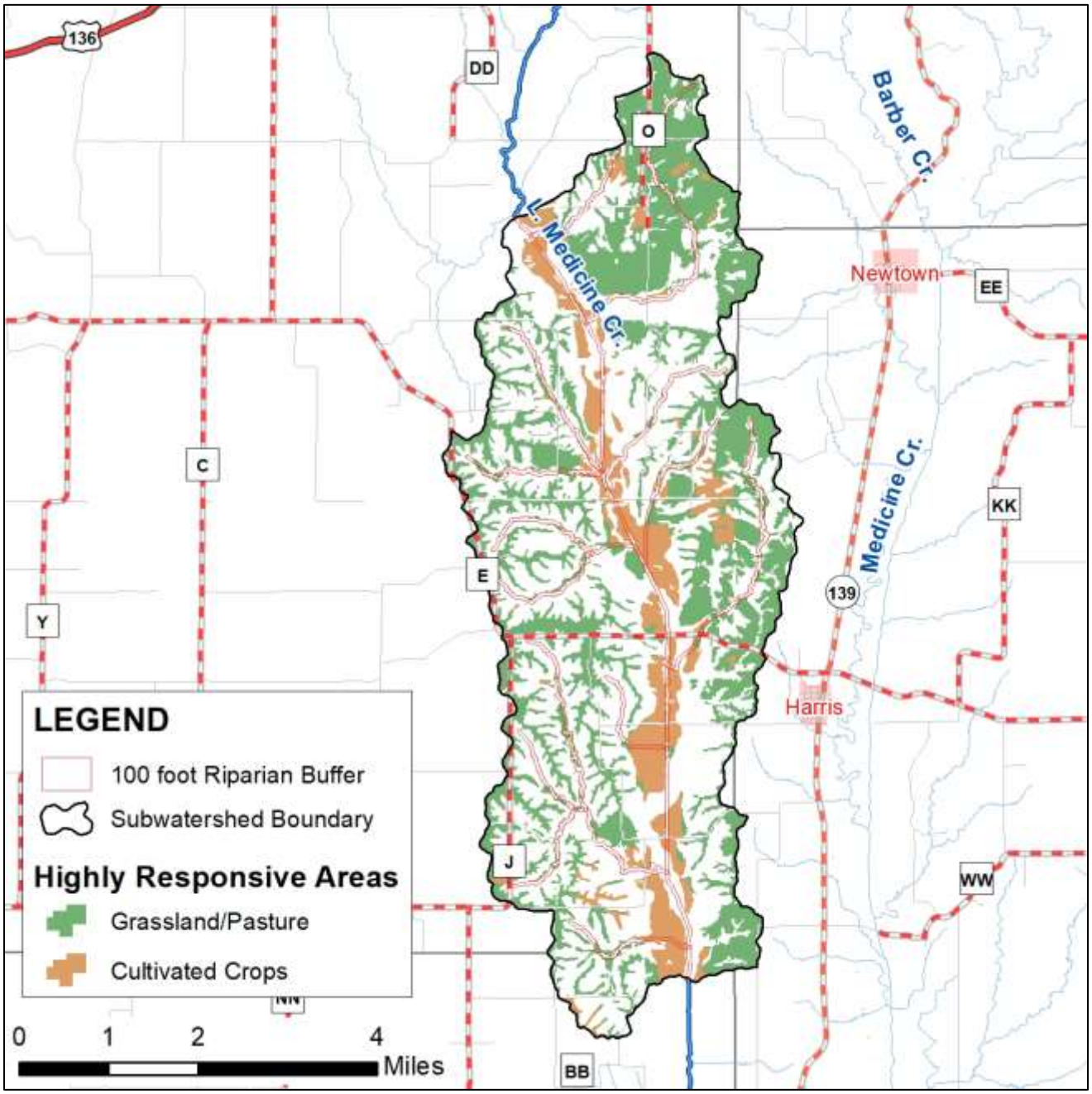

Figure B2. 12-digit HUC 102801030102

Figure B3. 12-digit HUC 102801030103